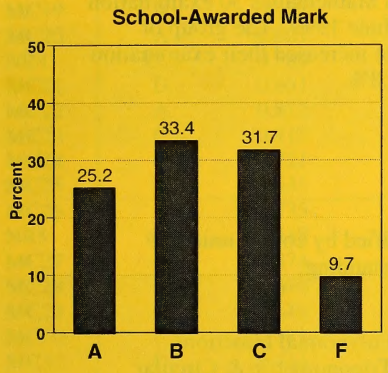
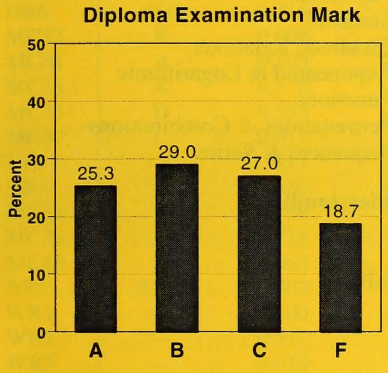
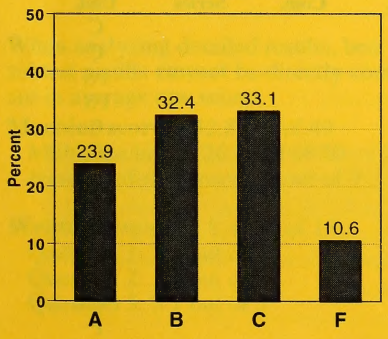
Mathematics 30

Diploma Examination Results
Examiners' Report for June 1999







The summary information in this report provides teachers, school administrators, and students with an overview of results from the June 1999 administration of the Mathematics 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that are provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 30 Diploma Examination consists of 40 multiple-choice questions worth 57.1%, nine numerical-response questions worth 12.9%, and three written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 9 205 students in Alberta who wrote the June 1999 examination.

- 89.4% of the 9 205 students achieved the *acceptable standard* (a final course mark of 50% or higher).
- 23.9% of the 9 205 students achieved the *standard of excellence* (a final course mark of 80% or higher).

Overall student achievement in Mathematics 30 was satisfactory and similar to the results for January 1999. The percentage of students who achieved the *acceptable standard* was 89.4%, compared with 90.4% in January 1999, and the percentage of students who achieved the *standard of excellence* was 23.9%, compared with 23.0% in January 1999. Students demonstrated improved performance over the last few years in permutations and combinations; all but one of the permutations and combinations questions had fewer than 50% of students answering incorrectly. Students are attempting the written-response questions: the percentages of no responses were 1.5% for written-response question 1, 1.3% for written-response question 2, and 2.7% for written-response question 3. Only 0.8% of students received no marks on the written-response portion of the exam.

Numerical-response question 1 was answered correctly by 91.6% of students, and numerical-response question 9 was answered correctly by 69.8% of students. This seems to indicate that students know how to do the order type questions in the numerical-response section.

Approximately 51.6% of the students who wrote the June 1999 examination were female. Of these, 89.8% achieved the *acceptable standard* for a final course mark, compared with 89.1% of the male students. Approximately 21.7% of the female students achieved the *standard of excellence* on the examination, compared with 26.3% of male students.

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Provincial Averages

- The average school-awarded mark was 67.8%.
- The average diploma examination mark was 65.9%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 67.2%.

Approximately 16.5% of the students who wrote the examination in June 1999 and received a school-awarded mark had written at least one other Mathematics 30 diploma examination during the June 1998 to June 1999 period. This subpopulation (1 519) achieved an average examination mark of 66.5% compared with 65.8% for the population (7 686) who wrote a Mathematics 30 examination for the first time in June 1999. The group of students who rewrote increased their examination average score by 15.8%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students achieving the *acceptable standard* will obtain a minimum mark of 50% or higher, and students achieving the *standard of excellence* will obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly.

Questions are classified by course unit and mathematical understanding.

Course Units:

Poly. Fn.	Polynomial Functions
Trig. Fn.	Trigonometric & Circular Functions
Stat.	Statistics
Quad. Rltns.	Quadratic Relations
Exp. & Log.	Exponential & Logarithmic Functions
Perm. & Com.	Permutations & Combinations
Seq. & Series	Sequences & Series

Mathematical Understandings:

P	Procedure
C	Concept
PS	Problem-solving

Blueprint

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC1	C	0.672	✓							C
MC2	B	0.771	✓							C
MC3	D	0.547	✓							PS
MC4	A	0.578	✓							PS
MC5	D	0.321	✓							C
MC6	A	0.665	✓							C
MC7	B	0.895	✓							P
NR1	429	0.921	✓							P
MC8	C	0.927		✓						P
MC9	D	0.639		✓						C
MC10	A	0.708		✓						C
MC11	D	0.587		✓						C
MC12	C	0.782		✓						P
MC13	D	0.616		✓						P
NR2	140	0.752		✓						P
NR3	21	0.460		✓						C
MC14	A	0.877					✓			P

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC15	B	0.824					✓			P
MC16	A	0.816					✓			PS
MC17	C	0.831					✓			PS
MC18	D	0.674					✓			PS
MC19	A	0.572					✓			P
MC20	A	0.621					✓			PS
NR4	12.3	0.589					✓			P
MC21	D	0.631				✓				C
MC22	A	0.812				✓				C
MC23	C	0.417				✓				PS
MC24	C	0.721				✓				C
MC25	B	0.635				✓				C
MC26	D	0.735				✓				PS
NR5	6.9	0.518				✓				C
MC27	B	0.874							✓	C
MC28	D	0.610							✓	P
MC29	C	0.616							✓	PS
MC30	C	0.881							✓	PS
MC31	D	0.444							✓	PS
MC32	A	0.462							✓	PS
NR6	480	0.715							✓	P
MC33	B	0.608						✓		C
MC34	A	0.709						✓		PS
MC35	A	0.570						✓		P
MC36	D	0.555						✓		PS
MC37	D	0.311						✓		P
NR7	120	0.811						✓		P
NR8	540	0.685						✓		P
MC38	B	0.799			✓					P
MC39	C	0.721			✓					PS
MC40	A	0.632			✓					P
NR9	3142	0.703			✓					P
WR1	—	0.500								
WR2	—	0.510								
WR3	—	0.610								

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 32.8 out of 49
Multiple-choice: 26.7 out of 40
Numerical-response: 6.2 out of 9

Written response: 9.4 out of 15
Question 1: 3.2 out of 5
Question 2: 3.3 out of 5
Question 3: 3.1 out of 5

Raw Score Averages for Machine-Scored Questions by Mathematical Understandings*

- Procedural (P): 13.8 out of 19
- Conceptual (C): 9.5 out of 15
- Problem Solving (PS): 9.6 out of 15

Raw Score Averages for Machine-Scored Questions by Course Unit

Poly. Fn.	Polynomial Functions	5.4 out of 8
Trig. Fn.	Trigonometric & Circular Functions	5.5 out of 8
Stat.	Statistics	2.9 out of 4
Quad. Rltns.	Quadratic Relations	4.5 out of 7
Exp. & Log.	Exponential & Logarithmic Functions	5.8 out of 8
Perm. & Com.	Permutations & Combinations	4.3 out of 7
Seq. & Series	Sequences & Series	4.6 out of 7

* Refer to the 1999–2000 *Mathematics 30 Information Bulletin, Diploma Examinations Program* for an explanation of mathematical understandings.

Multiple-Choice and Numerical-Response Questions

The following table gives results for three questions selected from the examination and shows the percentage of students in four groups that answered each question correctly. The comments following the table relate to some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

	Question Number		
Student Group	**MC 4**	**MC 37**	**NR 3**
All Students	57.8	31.1	46.0
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	88.4	60.7	82.2
Students achieving the *acceptable standard* but not the *standard of excellence* on the whole examination	54.6	24.0	41.3
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	26.3	12.4	11.5

The selected questions provide a good indication of student achievement of the curriculum standards in the units Polynomial Functions, Permutations and Combinations, and Trigonometric and Circular Functions.

4. A third-degree polynomial function is given by $P(x) = (x-2)(x+3)(x+4)$. If another polynomial function $Q(x) = kP(x)$, $k > 1$, then the graph of $y = Q(x)$ must have

***A.** a y-intercept that is less than -24
B. a y-intercept that is greater than -24
C. k more x-intercepts than the graph of $P(x)$
D. x-intercepts different from those of the graph of $P(x)$

For **multiple-choice question 4**, the majority of students who wrote the examination answered this question correctly. Almost 90% of students achieving the *standard of excellence* answered the question correctly as did about half of the students achieving the *acceptable standard* but not the standard of excellence. Many students incorrectly chose alternative B. These students knew that $P(x)$ had a y-intercept of -24 but incorrectly thought that the y-intercept of $Q(x)$ would be greater than -24 rather than less than -24.

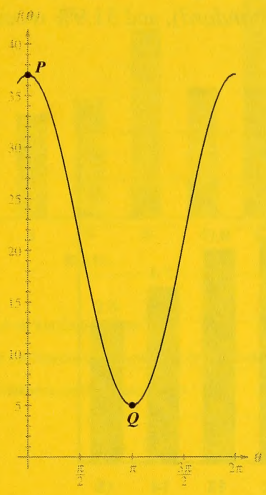
37. In the expansion of $(x + 2y)^8$, the numerical coefficient of the term containing x^4y^4 is

A. 70
B. 140
C. 560
***D.** 1 120

Multiple-choice question 37 was the most difficult question on the exam; only 31.1% of students answered it correctly. The question clearly distinguished between students who achieved the *standard of excellence* on the examination (60.7% answered correctly), those who achieved at the *acceptable standard* but not the standard of excellence (24.0%), and those who did not achieve the acceptable standard (12.4%). Many students incorrectly chose A as the answer, having used the value of ${}_8C_4$. They did not realize that this term would be multiplied by 2^4 or 16 to obtain the coefficient, ${}_8C_4 \times 2^4 = 70 \times 16 = 1120$, which is alternative D.

Use the following information to answer the next question.

The partial graph of the function $f(\theta) = a \sin(\theta + c) + d$ is shown below.



The graph has a maximum at $P(0, 37)$ and a minimum at $Q(\pi, 5)$.

Numerical Response

3. Based on the information above, the value of d, correct to the nearest whole number, is _____.

(Record your answer in the numerical-response section on the answer sheet.)

Answer: 21

On **numerical-response question 3**, students who achieved the *standard of excellence* performed well; 82.2% answered it correctly. In order to find the value of d, students needed to recognize that d represented the vertical displacement or midline of the sinusoidal curve. Students could then calculate d as the average of the maximum and minimum values.

i.e.: $d = \frac{37 + 5}{2} = \frac{42}{2} = 21$

Students could also recall that the maximum value of the function equals $d + a$ and that the minimum value of the function equals $d - a$. Thus, they could have solved a system of equations to find d.

i.e.: $d + a = 37$

$+ \; d - a = 5$

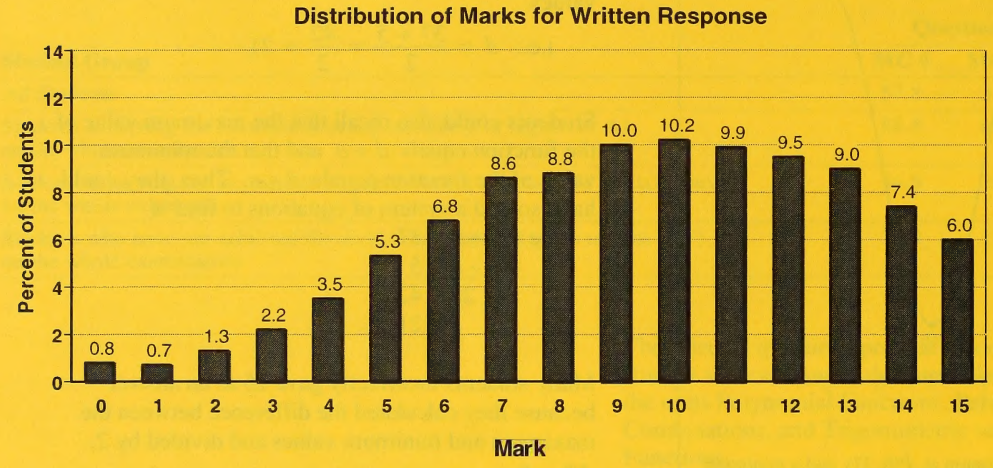
$2d = 42$

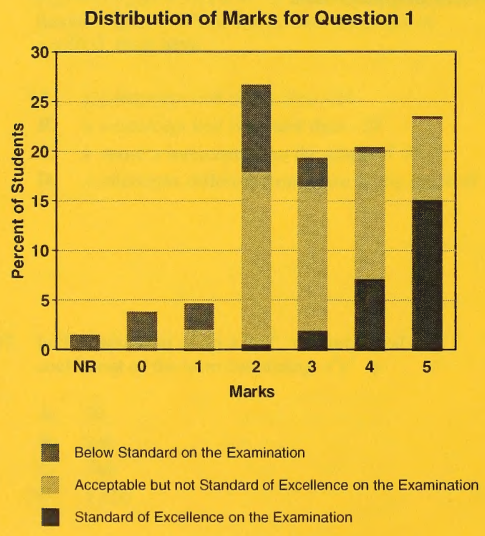
$d = 21$

Many students incorrectly gave 16 as an answer because they calculated the difference between the maximum and minimum values and divided by 2, $\frac{37 - 5}{2} = 16$, which is the amplitude of the curve, not the vertical displacement.

Written-Response Questions

The graph below shows the percentage of students achieving various marks on the written-response questions. The maximum mark obtainable was 15. Of the students who wrote the examination, 0.8% received no marks for the written-response questions, 70.8% received 8 marks or more (*acceptable standard*), and 31.9% received 12 marks or more (*standard of excellence*) out of 15.

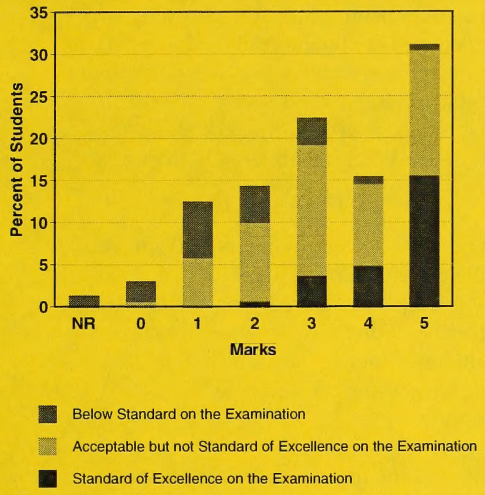




Question 1 required students, given a recursive formula, to determine the sale price of a mountain bike. Most students could easily calculate the price but had difficulty with the second bullet, which asked them to write an expression for t_n.

In the third bullet of this question, students were required to determine the day on which the price of the bike would fall below \$600. The students achieving the *standard of excellence* solved their t_n expression for n by using logarithms. Many of the students achieving the *acceptable standard* but not the standard of excellence solved this bullet by using repeated calculations. Many students tried to solve this bullet using logarithms: they found n to be 35.3 and then incorrectly answered that the price of the bike would fall below \$600 on the 35th day. The correct answer is the 36th day.

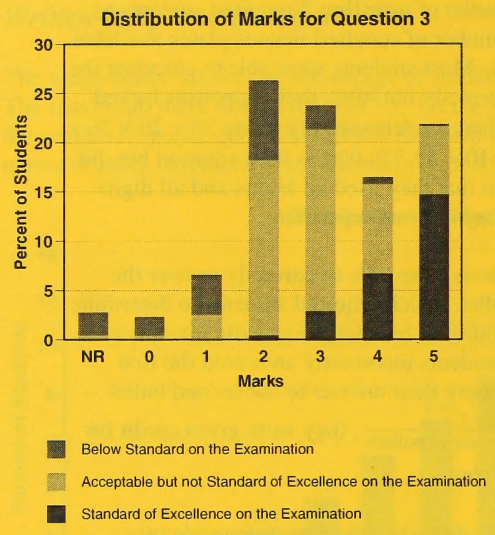
Distribution of Marks for Question 2



The first bullet of **question 2** required students to find the number of standard licence plates available in Alberta. Most students were able to calculate the number correctly but often their responses lacked clarity. Many students simply wrote $26 \times 26 \times 26 \times 10 \times 10 \times 10 = 17\,576\,000$ as their solution but did not explain that they used all letters and all digits and that they allowed repetitions.

Most students were able to correctly answer the second bullet, which required students to determine the probability of receiving a specific given licence plate. If students incorrectly answered the first bullet but gave their answer to the second bullet as $\frac{1}{\text{their solution to bullet 1}}$, they were given credit for the second bullet.

The third bullet asked students to provide two alternative proposals to increase the number of available licence plates. This bullet allowed students a fair bit of leeway in how they could answer. Student responses were often creative, and credit was given for such solutions as a change to the colour of the letters or to the shape of the licence plates. The weakness in responses to the third bullet was in the students' explanations. Many students used the same assumptions as they used in the first bullet but failed to restate these assumptions in the third bullet. Markers did not read into the student responses, so many students did not receive a 5 because of this failure to provide assumptions. Students should be reminded that to achieve full marks all aspects of the question must be addressed.



Question 3 required students to examine the solutions to an exponential equation shown by two different students. The students did well in verifying that neither students' solution was correct. The only weaknesses in this part of the question was the students' inability to read scientific notation from their calculators and their incorrect use of equal signs.

The second bullet of the question required students to identify the error made by each student and to explain why it led to an incorrect answer. Generally, students were able to identify the error in both students' solutions, but they encountered difficulty in explaining why student B's error led to an incorrect solution.

The final bullet of the question asked students to algebraically determine the solution to an exponential equation. Students achieving the *standard of excellence* usually solved the equation correctly by using logarithms. Students not achieving the standard of excellence had difficulty in solving the equation and often rounded their numbers very early in the solution process, which led to an incorrect final answer.

For further information, contact Kathy McCabe kmccabe@edc.gov.ab.ca, Len Bonifacio lbonifacio@edc.gov.ab.ca, or Corinne McCabe cmccabe@edc.gov.ab.ca at the Student Evaluation Branch at (780) 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.